25 January 1974, Volume 183, Number 4122 **SCIENCE**

Pioneer 10 Mission to Jupiter

If we are to understand the origin and evolution of the solar system, we must know more about the heavy planets situated beyond the asteroid belt. Collectively, these make up more than 99 percent of the mass of the planets, and they possess most of the angular momentum of the solar system.

By far the largest of the planets is Jupiter, which has a radius of 71,600 km and a mass 318 times that of Earth. Optically one of the brightest bodies in the heavens, Jupiter is reminiscent of a ham actor calling attention to himself. As seen from Earth, the planet has a unique banded structure, a big red spot, and variable coloration. Aside from the Sun, Jupiter is for radio astronomers the noisiest object in the sky. Sporadically, the planet emits great electromagnetic bursts equivalent in energy to those of megaton thermonuclear devices. These bursts are in addition to large quantities of synchrotron radiation, which indicate that Jupiter has a strong magnetic field. In contrast to the other planets, Jupiter also emits more energy in the infrared than the total energy it receives from the Sun. As befits a spectacular performer, Jupiter is accompanied by not one moon, but 12.

With these features as a lure, Jupiter has had the attention of Earth-based observers for a long time, and it is they who have provided most of the knowledge about it. The successful Jupiter flyby of Pioneer 10 has now added a substantial amount of information, which will grow as the records are analyzed in detail (see reports in this issue).

If anything, the new results add to the dramatic qualities of Jupiter. In its flyby of the planet, the spacecraft encountered large numbers of higly energetic electrons, protons, and helium nuclei and a correspondingly large exposure to radiation. For man, a whole body dose of about 500 rads is lethal. The spacecraft received an integrated dose of 200,000 rads from electrons and 50,000 rads from protons of energy above 30 Mev.

The spacecraft also encountered a large magnetic field. The total energy represented by Jupiter's field is 250,000 times that of Earth. In free space, the solar wind moves with a velocity of about 2×10^8 cm per second. However, at distances even greater than 7 million km from the planet, its magnetic field was found to be deflecting the wind.

Pioneer 10 experimenters discovered that the center of the magnetic dipole was removed 18,000 km from the center of the planet and that the axis of the dipole was at an angle of about 15° to the axis of rotation. What causes the magnetic field? Jupiter has an average density of about 1, in contrast to 5 for Earth. Does Jupiter have a core of metallic hydrogen, or perhaps a core of materials similar to that of Earth?

The flyby also added further evidence that Jupiter is dissipating energy in many ways. It showed that the planet radiates about 2.5 times as much energy as it receives. Pictures also lent further evidence of violent convective processes in the planet's atmosphere. Where is all the energy coming from?

One of the impressive features of the Pioneer 10 mission was the performance of the spacecraft and its scientific equipment. Although Pioneer 10 is about 800 million km distant, two-way communication with Earth is being maintained (travel time for a message is 45 minutes). One of the experimental setups required 15,000 commands from Earth. These were delivered and acted on. The craft, with its transmitter of only 8 watts, has been storing and sending tremendous quantities of data to Earth. Even after their radiation exposure during flyby, the electronics components continue to function well as Pioneer 10 proceeds on its way out of the solar system.—PHILIP H. ABELSON